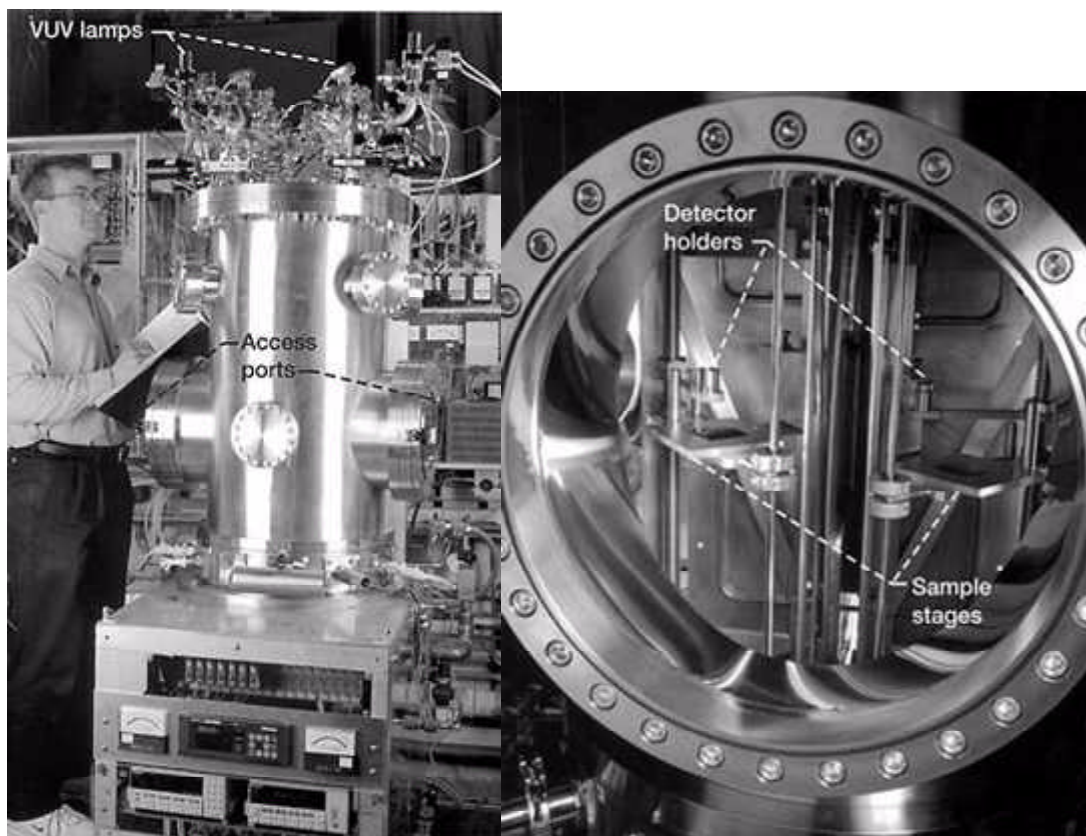


Facility and Methods Developed for Simulated Space Vacuum Ultraviolet Exposure Testing of Polymer Films

Vacuum ultraviolet (VUV) radiation of wavelengths between 115 and 200 nm produced by the Sun in the space environment can degrade polymer films, producing changes in their optical, mechanical, and chemical properties. These effects are particularly important for thin polymer films being considered for ultralightweight space structures, because, for most polymers, VUV radiation is absorbed in a thin surface layer. The NASA Glenn Research Center has developed facilities and methods for long-term ground testing of polymer films to evaluate space environmental VUV radiation effects. VUV exposure can also be used as part of combined or sequential simulated space environmental exposures to determine combined damaging effects with other aspects of the space environment, which include solar ultraviolet radiation, solar flare x-rays, electron and proton radiation, atomic oxygen (for low-Earth-orbit missions), and temperature effects.

Because the wavelength sensitivity of VUV damage is not well known for most materials, Glenn's VUV facility uses a broad-spectrum deuterium lamp with a magnesium fluoride window that provides output between 115 and 200 nm. Deuterium lamps of this type were characterized by the National Institute of Standards and Technology and through measurements at Glenn. Spectral irradiance measurements show that from approximately 115 to 160 nm, deuterium lamp irradiance can be many times that of air mass zero solar irradiance, and as wavelength increases above approximately 160 nm, deuterium lamp irradiance decreases in comparison to the Sun.



Glenn's VUV exposure facility. Left: Overview showing exterior components. Right: View of two of the four VUV exposure compartments through the access port window.

The facility is a cryopumped vacuum chamber that achieves a system pressure of approximately 53×10^{-6} torr. It contains four individual VUV-exposure compartments in vacuum, separated by water-cooled copper walls to minimize VUV radiation and any sample contamination cross interactions between compartments. Each VUV-exposure compartment contains a VUV deuterium lamp, a motor-controlled sample stage coupled with a moveable cesium iodide VUV phototube, and two thermocouples for temperature measurement. The left photograph shows the vacuum chamber and exterior equipment. Each VUV lamp is located at the top of the chamber with its projection-tube pushed through an O-ring compression fitting. The lamp assemblies are located on ports that can be isolated from the rest of the vacuum chamber, permitting maintenance or replacement of the lamps without breaking vacuum in the main chamber where the samples are located. The right photograph shows a view of two of the four interior VUV-exposure compartments, including the moveable sample stages and detector holders.

Glenn is using this facility to support testing of Next Generation Space Telescope sunshield materials that is being led by the NASA Goddard Space Flight Center and to develop an understanding of the wavelength, intensity, and temperature dependence of VUV-induced polymer degradation.

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